PATENT SPECIFICATION

Convention Date (United States): Aug. 31, 1933. **434,242**

Application Date (in United Kingdom): Aug. 31, 1934. No. 25151/34.

Complete Specification Accepted: Aug. 28, 1935.

COMPLETE SPECIFICATION

Improvements in and relating to Superchargers for Internal Combustion Engines

We, THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED, a British Company having its registered office at Crown House, Aldwych, London, W.C.2, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The present invention relates to superchargers for internal combustion engines, more particularly aeroplane engines.

The object of the ivention is to provide a compact arrangement of supercharger which can be attached as a unit to an engine.

According to the invention the supercharger, which is provided with two impellers mounted on a common shaft back to back on either side of a dividing wall of the supercharger casing, is so arranged that it can be mounted by its casing direct on the engine casing with the impeller driving gear attached as a unit to the supercharger.

In the present instance, the invention is shown applied to an internal combustion engine of the type having radial cylinders. It is to be understood, however, that it is not limited thereto necessarily. It is also shown as being applied to an engine using a carburettor. It is to be understood, however, that it can be used equally well with engines using other means of supplying fuel to the cylinders.

In the drawing, Fig. 1 is an end view looking toward the right hand side of Fig. 3, of a supercharger embodying our invention, the gearing and the wall enclosing the gearing in Fig. 3 being omitted; Fig. 2 is an end view of a part of the structure shown in Fig. 1 viewed from the opposite side and partly broken away; Fig. 3 is a sectional view taken on line 3—3, Fig. 2, and Fig. 4 is a diagrammatic perspective view of an operating means for the control valves.

Referring to the drawing, 10 indicates an end crank case wall of a radial cylinder type engine. It is provided with an opening in which is located a bearing 11 for the engine craft shaft 12. Fastened directly to an end wall 10 by a ring of bolts 13 is a supercharger embodying our invention. It comprises an outer casing 14 provided with a central partition wall or diaphragm 15, which divides the casing into two parts or stages, a lower pressure part or stage adjacent to the crank case wall 10 and a higher pressure part or stage on the side of the partition remote from the crank case wall 10. Outer casing 14 is formed in two parts the line of division being indicated at 16, to permit casting of the casing and its assembly, and it is provided with an annular web 17 on which partition wall 15 is supported.

In the lower pressure part or stage are walls 18 and 19 which define an annular inlet chamber 20 and an annular discharge chamber 21. Also, wall 19 defines with diaphragm 15 an impeller chamber 22 and an annular discharge passage 23 which connects impeller chamber 22 to discharge chamber 21. Formed integral with diaphragm 15 are a series of spaced curved vanes 24 which are located in passage 23 and serve to define air flow passages shaped to convert velocity into pressure.

Connected to inlet chamber 20 are two inlet pipes 25 which communicate with the atmosphere and are provided with valves 26 mounted on a spindle 27 to which is connected an actuating arm 28. Valves 26 are provided with openings 29 so that when in closed positions, some air can still flow past them. In the present instance, butterfly valves are illustrated as this is the type of valve we prefer to use. However, any suitable type of valve may be utilised. As will be clear, these valves control the supply of air to inlet chamber 20.

Mounted in suitable bearings 30 and 31 in the end walls of casing 14 is a hollow shaft 32 on which is fixed an impeller 33 located in impeller chamber 22. The eye or admission side of impeller 33 faces toward wall 10 and communicates with inlet chamber 20. The blades of impeller 33 are indicated at 34.

Connected to discharge chamber 21 are

[Pri

two discharge openings 35 to which are connected discharge pipes 36 which lead to the casing 37 of an air cooler or radiator. Pipes 36 are provided with heat radiating fins 38 for dissipating heat of the air passing through the pipes.

It will be noted that discharge openings 35 are located at opposite sides of discharge chamber 21 and that the discharge chamber 21 is in two sections, each in the form of a scroll as indicated particularly in Fig. 2, wherein 21*a* indicates one scroll communicating at its larger end with the left hand discharge opening 35, and 21*b* indicates the other scroll communicating at its larger end with the right hand discharge opening 35. Each scroll extends about 180 degrees. This construction gives a symmetrical arrangement for the discharge passages and serves to distribute the air evenly between the two discharge openings 35. Also, it enables the air discharge passages to be made of less axial width than would be the case were a single complete scroll used.

In the higher pressure part or stage are walls 41 and 42 which define an annular inlet chamber 43 and an annular outlet chamber 44. Also wall 41 defines with diaphragm 15 an impeller chamber 45 and an annular discharge passage 46 which connects impeller chamber 45 to discharge chamber 44. Formed integral with diaphragm 15 are a series of spaced curved vanes 47 which are located in passage 46 and serve to define air flow passages shaped to convert velocity into pressure.

Connected to inlet chamber 43 is an inlet pipe 48 which at its outer end is connected to the discharge pipe 49 of a fuel carburettor 50. In discharge pipe 49 is a throttle valve 51 mounted on a spindle 52 to which is fixed an actuating arm 53.

Fixed on hollow shaft 32 is an impeller 54 located in impeller chamber 45. The eye or admission side of impeller 54 faces in a direction opposite to that of impeller 33 and communicates with inlet chamber 43. The vanes of impeller 54 are indicated at 55. Connected to discharge chamber 44 are a series of circumferentially spaced discharge pipes 56 which lead to the cylinders (not shown) of the internal combustion engine of which the supercharger forms a part. Pipes 56 are equally spaced around discharge chamber 44 and extend first outwardly and then rearwardly to the engine cylinders.

On the outer end of hollow shaft 32 is a pinion 57 which meshes with a gear wheel 58 rotatably mounted on a fixed shaft 59. Shaft 59 is supported at one end in a socket 60 in the end wall 40 of casing 14 and at the other end in an opening 61 in a wall 62 attached to casing 14 and forming therewith a gear casing. The portion of the casing end wall in which socket 60 is located is supported by webs 60*a* as shown in Fig. 1. On a shaft 59 is a pinion 63 which meshes with a gear wheel 64 fixed on the outer end of a shaft 65. The outer end of shaft 65 is mounted in a bearing 66 in gear casing wall 62 and its inner end is connected to crank shaft 12. Shaft 65 passes through hollow shaft 32 in spaced relation to the walls thereof. Gear wheel 58 and pinion 63 both turn on shaft 59 and they are connected to each other through a suitable slip clutch 67 arranged to slip in case of overload on the gears. Any suitable form of slip clutch may be used.

Gear casing wall 62 and inlet pipe 48 are formed integral with each other and they are provided with a flange 68 for use in bolting the structure to casing 14.

The inlet of carburettor 50 is connected to the casing 37 of the air cooler so as to receive air from the pipes 36 after it has been cooled in the air cooler. The air cooler may be of any suitable construction. In the present instance, it is shown as comprising round tubes 69 provided with flared-out hexagonal shaped ends 70 which are joined together to form solid end walls. Only a few of the tube ends are shown on the drawing, but it will be understood that the entire area within the boundary of lines A is made up of the tube ends. The upper side of the bank of tubes is closed by a cover plate 71 and the surrounding sides and bottom of the tubes are enclosed by walls 72 and 73. As will be clear from Fig. 1, the arrangement is such that air from pipes 36 is spread out on all sides of tubes 69 and passes up over them to the carburettor. Air from the atmosphere flows through tubes 69 forming a cooling medium. The air cooler may be so located on the aeroplane that it faces in the direction of travel so there will be a good flow of air through the tubes. It may be suitably supported on a part of the aeroplane. In cover plate 71 are one or more inwardly opening air supply valves 74 which open to supply air from atmosphere directly to the inlet of the carburettor in case the pressure in the air cooler decreases below that of the surrounding atmosphere. Any suitable type of valve may be used. In the present instance, the valve is shown as comprising a valve member 75 held against its seat by a spring 76, the lower end of the spring being supported on a

cross strap 77, which forms also a guide for the valve stem.

Our invention may be embodied in an engine which does not have a carburettor, fuel being supplied to the engine cylinders by an injection arrangement. In case the engine does not have a carburettor, pipe 48 is connected directly to cover plate 71. In this case, air flows from the cooler directly to the inlet of the second supercharger stage.

Connected to actuating arm 28 is a spring 78 which serves normally to hold air inlet valves 26 in closed positions. Valves 26 are opened against the action of springs 78 by a rod 79 connected at one end to arm 28 and at the other end to an arm 80 on a shaft 81. The connection between rod 79 and arm 80 comprises a slot 82 in the rod in which is located a pin 83 on arm 80, thus providing a lost motion connection. On shaft 81 is an arm 84 connected by a link 85 to a hand control lever 86 pivoted on a shaft 87 and movable between stops 88 and 89. Also, on shaft 81 is an arm 90 connected by a link 91 to actuating arm 53 for the throttle valve. When throttle valve 51 is fully open, it strikes a stop 92 and the connection between link 91 and arm 53 is of a character such that after valve 51 is fully open, continued movement of control lever 86 can take place. To this end, link 91 is provided with a relatively long slot 93 at its end in which is located a pin 94 in the end of arm 53, and between the pin and the end of the slot is a spring 95. With this arrangement, after valve 51 strikes stop 92, further movement of link 91 can take place through the compression of spring 95. In Fig. 4, control lever 86 is shown in the "off" position, throttle valve 51 which controls the flow of air and fuel mixture to the engine and valves 26 which control the flow of air to the lower pressure stage of the supercharger being closed. It is held normally in this position by a suitable spring 96. As control lever 86 is moved forward, it functions first to open throttle valve 51, no movement of valves 26 occurring due to the lost motion connection between rod 79 and arm 80. After throttle valve 51 reaches a predetermined open position, which may be fully open position or some intermediate position, pin 83 engages the end of slot 82 so that valves 26 begin to open. When valve 51 is fully open, it strikes stop 92 after which further movement of lever 86 serves to open valves 26. It will be understood that control lever 86 is provided with suitable means (not shown) whereby it may be located in any adjusted position between the two stops 88 and 89.

The construction provides a two stage supercharger. When valves 26 are open, the air flows through inlet conduits 25 to the eye of the first stage impeller 33 and is discharged by it to the two scrolls of discharge chamber 21. The first stage or lower pressure stage of the supercharger compresses the air to a predetermined pressure. From discharge chamber 21, the air flows through conduits 36 to the air cooler or radiator 37 and passes over the tubes of the radiator to carburettor 50, or, if no carburettor is used, directly to the inlet of the second stage. In passing through carburettor 50, the air is charged with fuel and passes through inlet conduit 48 to the inlet chamber 43 of the higher pressure stage of the supercharger. From inlet chamber 43, the air passes to impeller 54 and is discharged by it to chamber 44. In passing through impeller 54 and the diffuser surrounding it, the fuel is vaporised and mixed thoroughly with the air, and the mixture is discharged through chamber 44 at a predetermined pressure. From chamber 44, the carburetted air or mixture flows through discharge pipes 56 to the cylinders of the engine.

When operating at light load, or in the case of an airplane, when operating near the ground, little if any supercharging is desired. At such times, throttle valve 51 is only partly open and valves 26 are closed. The closing of valves 26 results, in substance, in cutting out the first stage of the supercharger. When valves 26 are closed, only sufficient air flows through openings 29 to give stable operation of the first stage of the compressor and cool the same. Under these circumstances, the pressure in radiator 37 will be ordinarily less than atmospheric pressure, so that valves 75 open admitting air directly from the atmosphere to the carburettor. By this arrangement, therefore, the amount of supercharging is controlled automatically by the operating lever 86, which, as stated above, operates first to open throttle valve 51 a predetermined amount, after which it starts to open valves 26 to put the first stage of the supercharger into use. When valves 26 are closed, only a relatively small amount of air flows to the first stage of the compressor. This serves to decrease the density of the air in which impeller 33 runs, thereby decreasing the power required for turning impeller 33 when it is idle.

An important feature of our invention is the arrangement of the two stages of the supercharger so that their inlets face in opposite directions, the inlet of the lower pressure stage facing toward the engine and the inlet of the higher pressure stage

facing away from the engine. This permits of the carburettor and cooler being located in front of and below the supercharger and connected directly to the front portion of it, an advantageous arrangement in that it positions these parts where they are out of the way of the engine proper and so located that connections to them are made easily and are readily accessible. It is to be understood, however, that in certain respects our invention is not limited to this arrangement as in the case of an engine having no carburettor, or for some other reason, it may be desirable to have the arrangement of the supercharger reversed so that the inlet of the high pressure stage is facing toward the engine.

The back to back arrangement of the impellers is advantageous also in that it enables the supercharger to be made of relatively small axial length, since there are no air passages between the impellers but only a single wall. Also, in the case of a radial cylindered engine, the arrangement enables the supercharger to be brought within the confines of the engine.

It will be noted that air flow to the first stage of the compressor is through the space between the crank case and the adjacent wall of the supercharger. This serves to utilise for the air flow a space that is readily available and does not add to the axial length of the supercharger.

The carburettor connection is a part of the gear casing and is separate from the supercharger proper. Thus the supercharger is a unit which bolts directly to the engine casing and the gearing is a unit which bolts to the supercharger. By this arrangement, a different supercharger may be used without change in the gearing, or a different gearing may be substituted without change in the supercharger. And in either case, the carburettor and cooler are readily connected and disconnected. This is a most advantageous arrangement from a practical standpoint.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A supercharger for internal combustion engines, having two impeller stages with impellers mounted back to back on the same shaft and separated by a dividing wall of the impeller casing, the casing having provision for mounting direct on the engine casing, the impeller driving gear being attached as a unit to the supercharger.

2. A supercharger as claimed in Claim 1, in which the inlet to each stage faces outwardly from the dividing wall and vanes on opposite sides of the dividing wall provide air passages increasing in cross-sectional area in an outward direction.

3. An internal combustion engine provided with a two stage supercharger according to Claim 1 having its inlets facing outwardly in opposite directions secured to the engine with the inlet of the low pressure stage adjacent to the engine and having an air flow through the space between the crank case and adjacent wall of the supercharger and the discharge of the low pressure stage connected to the inlet of the high pressure stage.

4. A supercharger as claimed in Claim 1, in which the impellers are mounted on a hollow shaft which is connected through gearing with a driving shaft which passes through the hollow shaft.

5. A supercharger as claimed in Claim 4, having provision for mounting co-axially with the engine shaft by which it is adapted to be driven.

6. A supercharger as claimed in Claim 4, in which the connection between the engine shaft and impeller shaft includes a friction clutch.

7. A supercharger in accordance with Claim 1, having an inlet and a plurality of outlets for the first stage, an air cooler to which the outlets are connected on opposite sides, a carburettor having its inlet connected to the central portion of the cooler, means for supplying air directly to the air cooler, an inlet valve in the supercharger member inlet, a throttle valve for the carburettor, and means for opening the throttle valve at least partially in advance of the inlet valve.

Dated this 31st day of August, 1934.

A. S. CACHEMAILLE,
Crown House, Aldwych, London, W.C.2,
Agent for the Applicants.

Leamington Spa: Printed for His Majesty's Stationery Office, by the Courier Press.—1935.

Fig. 1

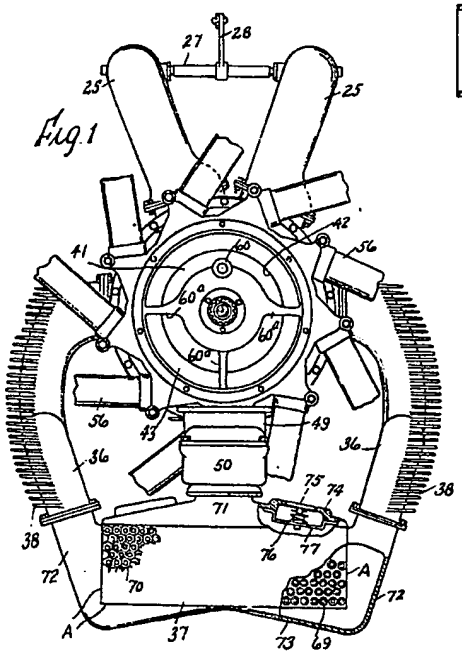


Fig. 3

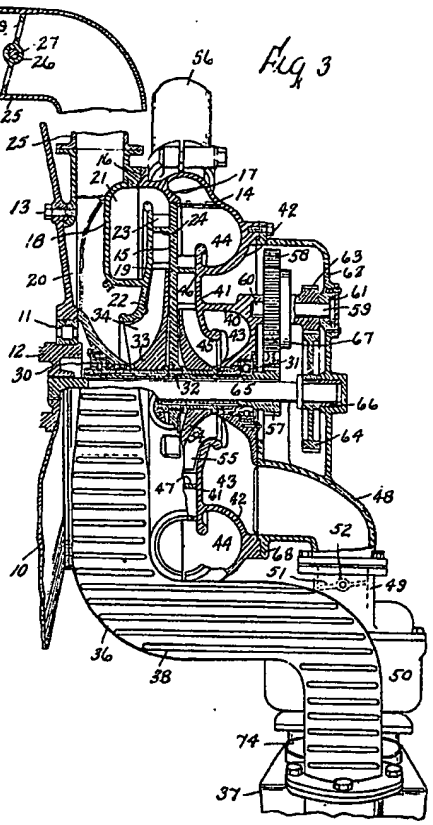


Fig. 2.

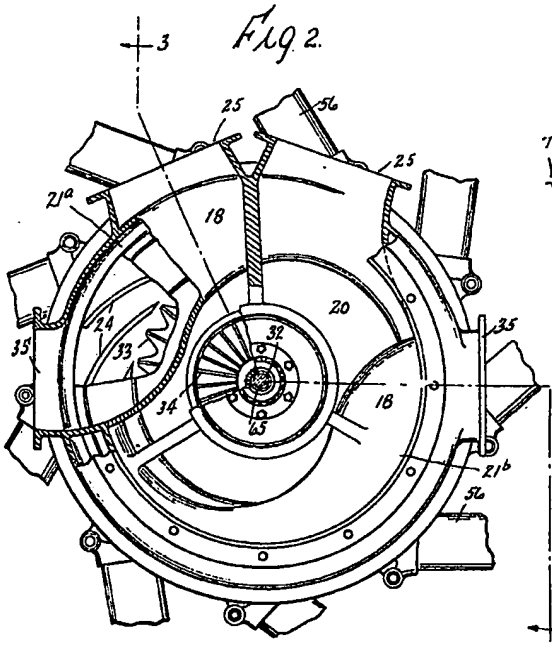
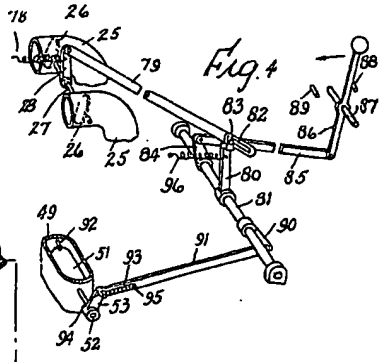


Fig. 4



Malby & Sons, Photo-Lith